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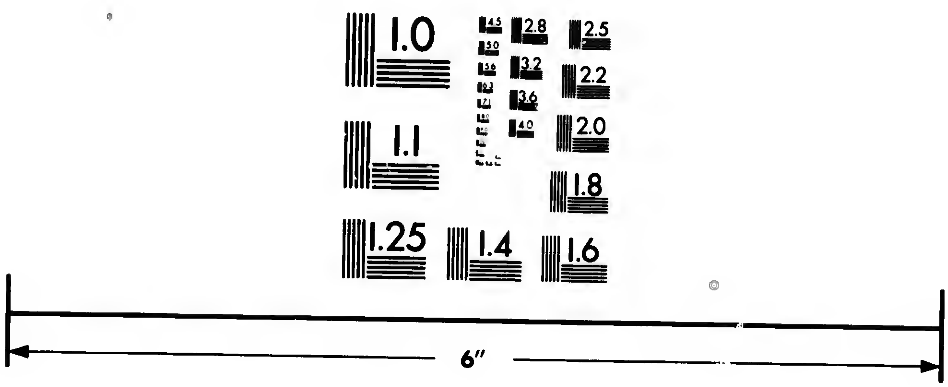

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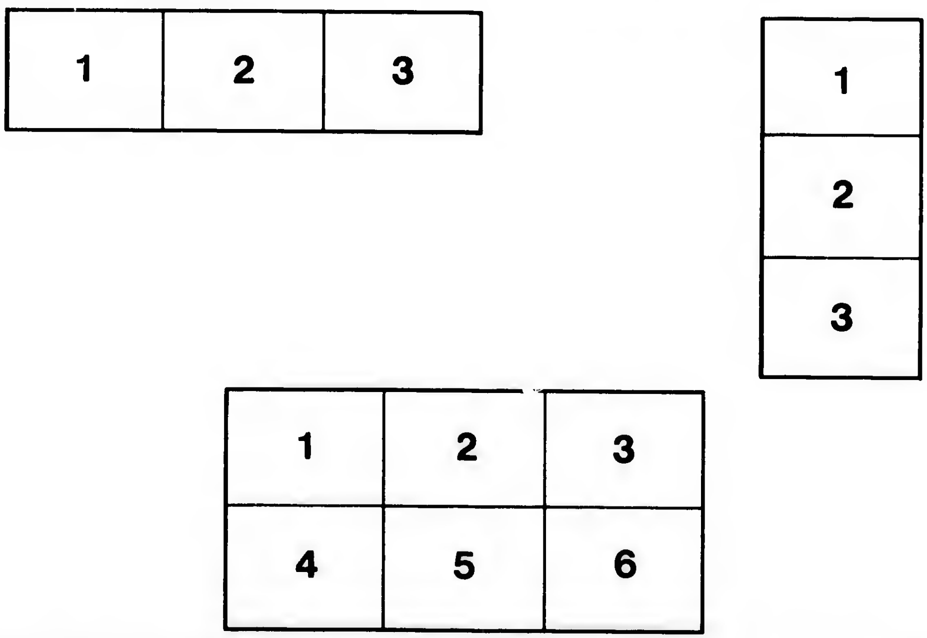
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INSTITUTION OF CIVIL ENGINEERS,

MARCH 30, 1858.

CHARLES HUTTON GREGORY, Esq.,

MEMBER OF COUNCIL,

IN THE CHAIR.

THE proceedings were commenced by the reading of the following abstract of a Paper entitled "Observations on the Electrical Qualifications requisite in long Submarine Telegraph Cables," by Mr. Alfred Varley.

The communications lately read, and so fully discussed, on the subject of submarine telegraphy, had suggested the enquiry, whether the cables, as at present constructed, did fulfil, in the best manner, the electrical portion of the problem. It was remarked, that there appeared to be some uncertainty, in the minds of those engaged in applying electricity telegraphically, regarding the laws of conduction and induction, and consequently of the nature of the conductor to be employed in long submarine circuits. The conclusions arrived at by the projectors of the Atlantic Cable were referred to, as it was believed that some errors had been inadvertently introduced into their calculations; but it was trusted that these criticisms would be received in a friendly spirit, as the only desire was to arrive at the truth.

The laws of conduction, as ascertained by the Author, as the result of direct experiments, were—1st., That a wire one mile long offered half the resistance of one two miles long. 2nd. That two wires, each two miles long, when placed side by side, which was the same as one of double the area, offered the same resistance as one wire one mile long. With regard to induction, the results of experiments tried by the Author and Mr. C. John Varley, showed that with flat plates it followed the same law as conduction, decreasing in regular proportions, as the insulating medium was increased; that was to say, if the inductive force through one plate was twelve, through two plates it would be six, through three plates, four, and so on. In a gutta-percha covered wire, it probably did not follow precisely the same law, as when the insulating materials were increased in depth, the surface was also enlarged, which partly counteracted the effect of greater thickness. Mr. C. J. Varley had tried some experiments which went to show, that in a wire one-tenth of an inch in diameter, coated to the depth of one-tenth of an inch with gutta-percha, making a total of three-tenths, when compared with one of the same size, coated to twice that depth, the inductive force of the former was to the latter as 4 to $3\frac{1}{4}$, or thereabouts, and not 4 to 2; but this result was only to be considered as an approximation.

The conclusion arrived at by the projectors of the Atlantic Telegraph, that in a submarine cable a small wire conducted more rapidly than a large one, was thought to be erroneous. If a battery of six cells, with six inches of surface in each cell, was connected through a circuit of nominally no resistance, a much greater quantity of electricity would be found to pass than when connected through a long fine wire perfectly insulated. In a battery with the same number of cells, but with twice the surface, and capable, consequently, of giving out twice the quantity, through a circuit of nominally no resistance, no more, practically, would be found to be passing, the resistance of the wire measuring out the amount, something in a similar way to water flowing out of a small pipe inserted into the bottom of a cistern. The series might be added to, cell by cell, until, practically, as much was forced through, as the battery originally generated, along a circuit of nominally no resistance. After this had been arrived at, a further addition would not make any perceptible difference, as there was already power enough to force through all that the battery was capable of generating, and the amount of force given out was always proportionate to the dynamic quantity flowing through the instruments. Intensity was only the medium which forced through this dynamic quantity.

The three following conclusions, which had been introduced into previous discussions, were then referred to:—1st, That a submarine circuit was a Leyden jar, which had to be charged to saturation, before passing a signal through; and consequently, the smaller it was, the sooner it was charged, therefore following a different law to that of a suspended wire, which probably followed the law of squares;—2nd, That the rapidity of signalling with voltaic currents was not affected by the intensity of the battery;—and 3rd, That magneto-electric currents travelled more rapidly than voltaic ones, and also increased in rapidity when their intensity was increased. The Author, in differing from these conclusions, did not wish it to be understood, that he thought the law of squares applied to submarine wires; for he knew of no electrical phenomenon which obeyed this law. It was submitted, that there was a material difference between a Leyden jar and a submarine circuit. In a Leyden jar the inner and outer coatings were perfectly insulated from each other. If they were not insulated, there could be no statical charge; induction, therefore, involved insulation. The fact was frequently overlooked, that the only real insulation in a submarine circuit, was the resistance opposed by the wire to the passage of the current, for it united both, being in contact with the earth at both ends. If it offered no resistance, there would be no insulation, and, consequently, no induction; and in proportion to the resistance it offered, providing always the insulating medium was of the same thickness, would induction be manifested. In the case of a suspended wire, the insulating medium of the air took the place of the gutta-percha of a submarine cable. The earth, the nearest conductor, being a long way off, and only on one side, no large amount of induction could take place between the earth and the wire; nevertheless it did take place to a certain appreciable extent. Indications of it had been noticed in a circuit 60 miles long, and it was believed that it could be perceived in much shorter circuits with delicate apparatus. If the wire was brought nearer to the earth, induction would be developed more strongly, and it might be brought down, step by step, until the condition of a submarine wire was approached, where the earth surrounded the wire on all sides, and was only separated from it by the three-sixteenths of an inch of gutta-percha, a substance possessing specifically a very much greater inductive capacity than air.

It was mentioned, that a wire of a given length offered the same resistance to a given quantity of electricity, that a wire of double the length did to half the dynamic amount. From this it was deduced, that all wires offered an infinitely small resistance to an infinitely small amount of electricity. The action of a battery when connected to send a current along a submarine wire was then considered, and it was remarked, that the wire and the earth being only separated by the thin layer of gutta-percha, induction could readily take place. Whilst the wire itself opposed great resistance to the quantity of electricity the battery was capable of generating, the effect would be to form a wave throughout the wire; but as there was but little resistance, comparatively speaking, to induction taking place, the greater portion of the first impetus would be occupied in charging the wire statically near the battery end. A very minute amount would begin immediately to flow at the further extremity, and in proportion as the tension of the wave of charge rose throughout the wire, so would the flow increase, both reaching their maximum together. When the wire was disconnected from the battery, this current would continue to flow out in a decreasing stream, as the tension of the wave of charge lowered, both ceasing at the same time. In the case of a suspended [redacted] wire, it was asserted, that as no induction worth naming could take place, there could be no accumulation of statical charge worth noticing; the whole impetus was therefore directed forward, and not diverted laterally, consequently, signals were found, for all practical purposes, to pass instantly. In the case of a submarine wire, the time elapsing between the contact of the battery and the appearance of the current, would be dependent on the sensitiveness of the instruments to record small amounts of electricity.

The relative amount of induction was decreased, when the wire was enlarged, for, whilst the substance increased as the square, the resistance decreasing in the same proportion, the surface on which induction depended only increased in regular proportion. Supposing four cables were employed as one conductor, although there would be only one-fourth of the resistance, signals would not pass through more quickly than through one, for the inductive surface was also increased four times; but if these cables were merged into one, whilst the inductive surface would be reduced one-half, the resistance would not be increased. It was believed, therefore, that if the diameter of a conductor was doubled, signals would pass through twice as quickly with the same depth of insulation.

The relations subsisting, telegraphically, between quantity and intensity of electric currents, demonstrated, that if the insulation was imperfect, larger dynamic quantities gave a better chance of working through. Cases had occurred where increasing the intensity of the battery had produced no perceptible advantage, whilst increasing the surface in each cell had a very decided effect. A case was instanced where, on a leaky circuit of upwards of 212 miles in length, the deflection on the galvanometer had been raised from 23° to 53°, by increasing the surface, without adding to the number of cells.

The effect of employing batteries of very high intensities for submarine wires, with a view to increased rapidity of signalling, was then considered; and it was stated that, as with high intensities there was greater energy to force through resistance, the wave of charge would arrive at its maximum more quickly than with a lower intensity, and signals would be passed through sooner. The reason why an increase in the rate with voltaic currents had not hitherto been observed, when the intensity of the battery had been increased, was explained.

The results with magnetic electric currents, would, it was thought, be more decided, for their intensity was many times as great as that of the voltaic currents which had been employed. For instance, it would take twelve hundred cells to spark through a space of air only one-hundredth of an inch; but this intensity would be a very low one for a magneto-electric current, whose intensity could be increased to almost any extent. A voltaic battery might be compared to a hydraulic ram, and a magneto-electric machine to a fly-press; both might be capable of raising a given weight, but one would do it more suddenly than the other.

In conclusion, it was remarked that it was impossible to believe, that nature, whose laws, science, as she progressed, invariably proved to be simpler and yet more simple, should have one law for one conductor, and another for another; and that electric currents, having all the same properties in common, should be differently affected when their intensity was increased, or diminished.

The second Paper read was "Description of the Improvements on the Second Division of the River Lee Navigation, with Remarks on Canals generally," by Mr. R. C. Despard.

In the year 1854, Mr. Beardmore, M. Inst. C.E., communicated to the Institution an account of the works on the first division of this navigation, extending from the Thames to Old Ford Lock, entirely within tidal influence. The second division commenced at Old Ford and terminated at Tottenham, a distance of $4\frac{1}{2}$ miles. The works on the latter division, which were not proceeded with until the end of 1855, consisted of,—

First—The removal of Old Ford Lock, and the construction on its site of a pair of locks of greater width and increased depth of water over the sills.

Second—The construction of wharf and towing-path walls, and raising the old, or forming new banks between Old Ford and Homerton Lock, a distance of one mile three furlongs. Also removing Homerton Lock, so as to make the whole length, from Old Ford to Tottenham, into one level.

Third—The construction of a pair of stop-gates and a new bridge at Pond Lane, between Homerton Lock and Lee Bridge; and

Fourth—Deepening, by means of dredging, the main river from Homerton Lock to Tottenham.

The works for the Old Ford locks were commenced by forming a cofferdam, consisting of a single row of whole timber piles, below the old lock;—a trench having been previously excavated, which was filled up on the outside of the piles with puddle, to within 4 feet of Trinity high-water mark. This dam remained perfectly sound and water-tight during the whole of the operations. A "stank" having been placed across the upper level of the navigation, the removal of the old lock was proceeded with. The foundations, which were composed of blue lias concrete, were laid in the bed of gravel and sand uniformly underlying this district, as shewn in the works at the new reservoirs of the East London Water Company at Lee Bridge and Old Ford, and at the Victoria, West India, Commercial, and London Docks. This stratum permitted the percolation of water, emitting a strong odour of sulphuretted hydrogen, and evidently impregnated with iron, which was deposited in the form of hydrated oxide, on exposure to the atmosphere.

The principal dimensions of the locks were: the Eastern lock, 96 feet long by 18 feet 6 inches wide, having the lower cill laid at the level of 10 feet below, and the upper one 3 inches above high-water mark. The Western lock was 90 feet long by 16 feet wide; the lower cill being laid at the level of 7 feet 9 inches below high-water mark, and the upper one at the same level as in the other lock. The pier between the locks was 138 feet long, 12 feet wide, and 19 feet high.

The walls and pier were of brickwork, faced with hard pavior stocks, set in Portland cement, and backed with concrete; hoop-iron bonds being introduced at every eighth course. The invert of the smaller lock was composed of Portland cement concrete, that of the larger lock was originally of the same material, but owing to the percolation of water, a width of 6 feet in the centre was of two half brick rings set in cement.

The principal points of novelty were, the combined pointing cills and hollow quoins, both of cast-iron, and the sluices. The cills were each cast in one piece, and were of sufficient length to allow of the ends being firmly built into the lock walls, thus forming the foundation plate for the gate pivots. The arrangements were such, that each cill and pair of hollow quoins were placed in position and firmly bedded in less than two days. When the locks were sufficiently advanced, the gates, framed ready for fixing, were lowered entire, instead of being, as usual, erected piecemeal in the lock-pit—a tedious operation, necessarily performed after the lock-walls were built; whilst, by the plan adopted, the construction of the gates was entirely independent of the lock-work. The balance beams, anchor caps, foot sockets of the heel posts, and fender frames (of which there were four built into each lock wall,) were all of cast-iron.

The culverts and sluices were all placed in the pier between the locks. There were five culverts; one for filling and one for emptying each lock, and one for connecting the two locks. In consequence of the confined lateral space, those for the western lock had to be built above those for the eastern lock—the roof, or flooring, separating them, being formed of cast-iron plates. The sluices were, to a certain extent, self-acting. This was effected by making them somewhat in the form of a caisson, which worked perpendicularly and nearly watertight in a chamber. There were two valves in the caisson, one for emptying the chamber or allowing the water to run off, and the other for filling, or allowing the water from the upper level to pass into the chamber. When it was required to raise, or open the sluice, the former valve was opened, which released the water in the chamber, and left against the sluice the upward pressure due to the difference between the two levels (ordinarily 10 feet,) which tended to force it up. When the sluice was to be lowered, the water was generally at the same level on both sides, in which case it descended by its own weight; but should it be necessary to lower it against a pressure, the water from the upper level was allowed to run into the chamber, so as to produce a downward pressure. These sluices could be raised by one man in half a minute, and by their aid the larger lock could be filled or emptied in less than two minutes. They were designed and manufactured by Messrs. Lawrence, Brothers.

The wharf and towing-path walls were formed of headers of Kentish ragstone, backed with concrete. The material used for raising the towing-path was almost entirely obtained by dredging the main river, and consisted of gravel mixed with a small proportion of peat and mud. This made a perfectly water-tight bank, without the use of puddle. On the opposite side of the navigation a new bank, 10 feet in width at the top, with an inner, or water slope of 2 to 1, and an outer slope of $1\frac{1}{2}$ to 1, was formed from side cutting. In the centre of this bank there was a puddle wall 6 feet in width. By these means the navigation had been widened, so as to allow of a lay-bye for barges along the whole length, and thus to afford available water frontage to a large area of land.

The stop-gates at Pond Lane were constructed in order to allow the water to be drawn off at Old Ford Locks, without incurring the expense of a dam. They were 22 feet in width, and the cill was laid at the level of 7 feet 11 inches below the Lee Bridge headmark. Their construction was very similar to that of the Old Ford Locks, except that the cast-iron pointing cill formed nearly a square nosing to a brick cill.

A steam dredging machine was employed for deepening the river, the average cost of raising material being from tenpence to elevenpence per cubic yard, according to the weight, including a "lead" of $1\frac{1}{2}$ mile and allowing for wear and tear of machinery.

The total cost of the works was about £22,000, which amount included £4,000 for land, and £2,000 for plant, now being used on works higher up the river. They were designed and executed by Mr. Beardmore, M. Inst. C.E., assisted by the Author, without the intervention of a contractor.

In the second part of the paper, it was argued, that canals were still extensively useful, as a means of conveyance, and that they might be rendered more so, by combination with railways. The returns of the Grand Junction Canal Company, which had to contend with the formidable opposition of the London and North Western Railway Company, gave an actual increase from 1840 to 1856, of 262,942 tons per annum, or $28\frac{1}{2}$ per cent.; although this was liable to fluctuation from year to year, the average of each quinquennial period, showed that the increase had been gradual and progressive. This result was in some degree due to a considerable reduction in the tolls, and also to the development of the resources of the country, due to railways; so that canals were now actually profiting by that which in the first instance threatened to annihilate them. The traffic on the River Lee Navigation, which had to compete with the Eastern Counties Railway for its whole length, had steadily increased during the years 1851-6, 25 per cent. in tonnage, and about 50 per cent. in receipts, notwithstanding that the tolls had been considerably raised.

As an example of a different class, namely, of a canal working in conjunction with a railway, the Trent and Mersey system worked by the North Staffordshire Railway Company was cited; and it was stated that, during the ten years from 1846 to 1856, the tonnage must have increased 40 per cent. Under this head, the enormous amount of coal distributed by the Regent's Canal, from the Great Northern Railway, was also quoted. It appeared, that in 1857, the quantity of coal passing upward from the River Thames and Great Northern Railway was 554,788 tons, whilst that passing downwards from the Grand Junction was only 4,997 tons. The former amount included 156,927 tons from the Great Northern Railway. Thus were combined the rapidity of transit of the railway, and the facility of distribution by water communication, by means of the Canal and the Thames.

As to the system of management on canals, it was suggested, that interchange of traffic should be encouraged, by the adoption of a uniform system of tonnage rates per mile; that there should be unanimity of purpose and cordiality of feeling; that the idea of competition between canals and railways should be abandoned, and that they should mutually assist and be auxiliary to each other, rather than antagonistic, as had too frequently been the case. The extensive establishments at Bull's bridge on the Grand Junction Canal, for the Great Western Railway, and at Maiden-lane on the Regent's Canal, for the Great Northern Railway, and the arrangements of the South Yorkshire Railway and River Dun Company, were quoted. It was also suggested, that it might be of advantage to the companies to encourage the establishment of manufactories on the canal banks.

Steam tugs were gradually coming into favour for working the traffic. The difficulty had, hitherto, been to use vessels of sufficient power, without injuring the banks. This had, to a certain extent, been overcome on the Regent's Canal, where the tug, constructed by Mr. Inshaw, of Birmingham, had a screw on each side, the one being right, the other left handed, so that the wash from the one tended to neutralize that from the other. On the Aire and Calder navigation four steam towing barges were employed for the goods traffic, and a different class of towing barge for minerals. Tugs might be employed advantageously on long levels, say of over two miles in length, but where the traffic was large they should not be allowed to pass through the locks, and on shorter lengths horses should continue to be used. Time bills should be adopted, so that steam might be continuously employed. The speed should not exceed from 4 to 5 miles per hour, as at higher rates, the resistance of the water would be so great, as to require an unnecessarily large expenditure of power, and the wave created would tend to destroy the banks.

It was specially resolved, that in order to insure a fuller attendance of Members than could be obtained on Easter Tuesday, the meeting should be adjourned until Tuesday evening, April 13th, when it was announced the Monthly Ballot for Members would take place, and the following Paper would be read: "Investigation into the Theory and Practice of Hydraulic Mortar," by Mr. G. Robertson, Assoc. Inst. C. E.

INSTITUTION OF CIVIL ENGINEERS.—Tuesday, April 13th, at 8 p.m. "Theory and Practice of Hydraulic Mortar," by Mr. G. Robertson, Assoc. Inst. C. E.